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BIOLOGICAL EVALUATION OF DAMAGED DOUGLAS-FIRS ON THE BAKER RIVER RANGER DISTRICT MT. BAKER - SNOQUALMIE NATIONAL FOREST

BY

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INTRODUCTION

During September 1973 several Douglas-fir, *Pseudotsuga menziesii*, plantations on the Baker River Ranger District, Mt. Baker-Snoqualmie National Forest, were examined and found to have a high incidence of stem cankers and dead tops (reference 5200: Forest Insect and Disease Control, memo to the record entitled "Preliminary Douglas-fir canker survey on Baker River Ranger District, Mt. Baker N.F." by Robert D. Harvey, Jr. dated November 21, 1973).

Five circular plots each 1/20 acre in size were established in one 60 acre plantation (Dry Creek Unit No. 3, elevation 750 feet) to estimate the amount of damage and follow the progress of the damage for several years. A metal tag was placed on each tree within the plots for future reference.

Dry Creek Unit No. 3 was first planted in 1952 and then replanted in 1963 and 1969. The most recent planting was Douglas-fir (Demming seed source, 1-2 stock approximately 3 feet tall). Average stocking was 850 trees per acre (spacing 7 feet by 7 feet).

During the 1973 examination, 42.5 percent of the trees in the plots were cankered; 26.8 percent had dead tops. In some instances where top dieback occurred, a lateral branch assumed dominance and the tree appeared to have recovered from the initial damage. Samples of representative cankers were collected for laboratory analysis. Although a number of fungi including *Fusarium* spp., *Aureobasidium pullulans*, and *Cladosporium* spp. were cultured from cankers, none of these organisms were suspected as being the causal agent. Specimens of cankers were forwarded to Dr. Alvin Funk, Pacific Forest Research Centre, Victoria, B.C. Galleries of *Laspeyresia* bark miners were identified and suspected as contributing to the formation of the cankers. To determine the initial cause of the damage additional data were collected in July 1974.

MATERIALS AND METHODS

The five plots in Dry Creek Unit No. 3 were reexamined on July 9, 1974. Data were collected on tree height and incidence of top-kill, cankers, and dead branches. The presence of fungus fruit bodies on damaged trees was also noted.

Stem sections (30) exhibiting injuries were removed from trees adjacent to the plots for laboratory analysis. Additional collections (25) were

made for comparison from three other units at higher elevations. The units examined were Sulphur Creek Units 6, 7, and 9. Elevation ranged from 2960 to 3150 feet. Planting was done in 1960 and 1961. Damage to trees (Douglas-fir, *P. menziesii*; western hemlock, *Tsuga heterophylla*; and western redcedar, *Thuja plicata*) in these units appeared to be the result of snow movement. Many trees were deformed and had broken tops and damaged branches.

In the laboratory, sections of damaged stems were surface sterilized with 0.5% chlorox solution. Wood chips were aseptically removed and plated onto the following agar media: potato dextrose agar (PDA), malt agar (MA) and malt agar supplemented with streptomycin sulfate (MAS). Cultures were incubated at room temperature (24-25 degrees C) for several weeks until identification of fungi could be made. Subcultures were made to isolate and identify species. Fungi that could not be identified were submitted to Dr. Michael J. Larsen, Botanist, Center for Forest Mycology Research, Madison, Wisconsin.

RESULTS

Data collected from trees in the five plots in Dry Creek Unit No. 3 are summarized in Table 1. A total of 209 trees were examined. The percent of cankered trees per plot ranged from 13.6 to 76.6 (average 53.6); the percent of top-killed trees ranged from 6.8 to 75.5 (average 45.0). No fungal fruit bodies were observed on any of the trees. No trees had died since the initiation of the study; however, 16 percent of the trees exhibited poor vigor.

Data collected on laboratory samples are presented in Table 2. Most injuries were confined to main stems or terminal shoots. A resin-soaked ring was present in cross sections of many damaged stems. These rings were dated for each sample and presented in Table 2. Samples were sectioned on a microtome to examine the anatomy of the tissues. The dark resin-soaked ring (which was visible to the naked eye) contained crushed tracheids, displaced wood rings, and large, thin-walled parenchyma cells, many of which were resin-soaked. Similar types of injury have been described by Porter (1959) and Peace (1962) as associated with low temperature injury to conifers. To test the hypothesis that the initial damage was physiogenic, weather records for the years 1967 to 1974 were obtained from Upper Baker River Dam station in Concrete, Washington (courtesy of Puget Power). This weather station is only a few miles from Dry Creek Unit No. 3. Data were analyzed to determine if any unusual weather conditions occurred during those years in which damage was noted to the trees in the unit. Data are summarized in Table 3.

Freezing temperatures in this area usually occur from mid-October into March; rarely do temperatures drop below 10 degrees F. During the winter period of 1968-69, temperatures dropped to -5 degrees F. from a previous minimum temperature of 20 degrees F. (Table 3). This sudden drop in temperature could cause damage to tissues not fully hardened-off.

During the winter period of 1970-71 freezing temperatures occurred earlier than usual. Mild weather preceding the cold period was not conducive to the normal cessation of growth. Unhardened tissues were thus predisposed to damage by freezing temperatures occurring in November (Table 3). Low temperatures also occurred during the winters of 1971-72 (lowest recorded temperature 1 degree F. on January 28) and 1972-73 (lowest recorded temperature 6 degrees F. on December 8), however, the preceding 30-day period of freezing temperatures should have initiated the hardening-off process, so little cell damage would have occurred.

Tissue isolations from representative damaged trees from Dry Creek Unit No. 3 yielded several organisms, none of which are known to the aggressive pathogens (Table 4). Most of these fungi are saprophytes commonly isolated from damaged woody tissues. Many of the same organisms were found in tissues from snow-damaged trees in Sulfur Creek Units 6, 7, and 9 (Table 5). The most frequently isolated fungi were *Aureobasidium pullulans* and *Fusarium* spp. (Tables 4 and 5).

DISCUSSION AND CONCLUSIONS

Differences in freezing resistance of provenances of many woody plant species have been reported (Weiser, 1970; Sakai and Weiser, 1973). Differences also exist in tissues or parts of a plant (Weiser, 1970). The timing of cold hardening in the autumn differs significantly among clones within a species. Usually northern clones harden-off earlier than more southerly or coastal clones. These differences must be considered when selecting planting stock properly adapted to a site. For example, Pacific Coast collections of *P. menziesii* resist freezing injury to winter buds to only -4 degrees F.; whereas, collections of *P. menziesii* var. *glauca* from Idaho and Colorado resist injury to -58 degrees F. When woody plants are fully acclimated in mid-winter, the tissues of the living bark of many hardy species have been found to withstand cooling to -219 degrees F. (Sakai and Weiser, 1973).

It is most probable that the damage noted to the Douglas-firs in Dry Creek Unit No. 3 was induced by cold weather occurring prior to cessation of growth and hardening-off of tissues. It is also possible that the plantation is located in a local frost pocket. Several ridges resembling glacial eskers transected the unit. Trees located in these natural depressions would be subjected to frost or winter damage from cold air trapped in these areas.

RECOMMENDATIONS

The majority of trees that were damaged by cold temperatures in Dry Creek Unit No. 3 have recovered. Some of the trees may have low value in the future due to the production of forked and multiple tops; however, trees of poor form and vigor can be removed in future thinnings. No increase in mortality has occurred over a two-year period.

Persons responsible for reforestation on the District should take special care in the selection of species and seed sources that are adapted to each planting site. In some instances where frost is a problem, the overstory should not be removed until the regeneration is over 6 feet tall. The overstory will provide some protection to the understory trees during the most susceptible stages of development.

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TABLE 1.-- Data collected from cankered and top-killed Douglas-firs in Dry Creek Unit No. 3, Baker River Ranger District - 1974

Plot No.	No. Trees	Live Height (inches)	Percent of Trees cankered	Percent of Trees top-killed	Percent of Trees wounded	Percent of Trees w/dead branches
1	47	73.4	76.6	61.7	89.4	55.3
2	49	53.7	71.4	75.5	79.6	75.5
3	32	75.3	34.4	15.6	75.0	25.0
4	44	59.9	13.6	6.8	31.8	6.8
5	37	76.2	64.9	54.0	67.6	67.5
Totals	209	66.8	53.6	45.0	68.9	47.3

TABLE 2.--Data collected from frost and snow-damaged trees on the Baker River Ranger District - 1974

Collection Area	No. of Samples	Ave. Stem diameter (cm)	Location of injury (number of samples)				Occurrence of resin rings year of injury			
			Main Stem	Lateral Branch	Terminal Shoot	Main Stem-Lateral Branch	1974	1973	1972	1971 or older
Dry Creek Unit #3	35	2.8	17	--	12	7	5	--	14	17
Sulfur Creek Unit #6	11	2.9	5	1	4	2	5	2	5	4
Sulfur Creek Unit #7	6	2.7	2	--	4	1	3	--	1	5
Sulfur Creek Unit #9	11	2.8	4	2	5	1	2	5	7	8
Totals	63	2.8	28	3	25	11	15	7	27	34

TABLE 3.-- Summary of weather data recorded at the Upper Baker River dam station, Concrete, Washington 1967 - 1974

Winter period (Oct. to March)	Date of first temperature record of:-			Number of days of 32° or lower temperature in 30 day-period preceding date of first temperature record of:-	
	32°F.	20°F.	10°F.	20°F.	10°F.
1973-74	Nov. 1	Jan. 1	--	10	--
1972-73	Oct. 11	Dec. 4	Jan. 6	8	23
1971-72	Oct. 16	Dec. 7	Jan. 26	8	27
1970-71	Oct. 7	Nov. 22	--	9	--
1969-70	Oct. 14	--	--	--	--
1968-69	Nov. 6	Dec. 28	Dec. 28	22	0
1967-68	Nov. 2	Dec. 13	--	16	--

TABLE 4.--Microorganisms associated with damaged Douglas-firs in Dry Creek Unit No. 3 Mt. Baker-Snoqualmie National Forest

Microorganism	Numbers of trees yielding 1/	Percent of trees yielding
Imperfect Fungi		
Alternaria sp.	1	3.3
Aspergillus sp.	1	3.3
Aureobasidium pullulans	16	53.3
Epicoccum nigrum	1	3.3
Fusarium sp.	13	43.3
Geotrichum sp.	1	3.3
Penicillium sp.	6	20.0
Yeasts	2	6.7
Bacteria	2	6.7
Unidentified basidiomycete	4	13.3
Unidentified	5	16.7

1/ Isolations were made from 30 damaged trees.

TABLE 5.--Microorganisms associated with snow-damaged trees in Sulfur Creek Units 6, 7, and 9, Mt. Baker-Snoqualmie National Forest

Microorganism	Numbers of trees yielding 1/	Percent of trees yielding
Imperfect Fungi		
Aspergillus sp.	1	4.0
Aureobasidium pullulans	8	32.0
Fusarium sp.	11	44.0
Penicillium sp.	1	4.0
Rhizoctonia sp.	2	8.0
Yeasts	1	4.0
Bacteria	5	20.0
Unidentified ascomycete	1	4.0
Unidentified loculoascomycete	1	4.0
Unidentified basidiomycete	5	20.0
Unidentified	4	16.0

1/ Isolations were made from 25 damaged trees.